LOUISIANA STATE UNIVERSITY
AND AGRICULTURAL AND MECHANICAL COLLEGE
Center for the Study of Public Health Impacts of Hurricanes

February 12, 2007

The Honorable Johnny Bradberry
Secretary, Louisiana Department of Transportation and Development
1201 Capitol Access Road
Baton Rouge, Louisiana 70804-9245

RE: Transmittal of 'Team Louisiana' Final Report: *The Failure of the New Orleans Levee System during Hurricane Katrina*

Dear Secretary Bradberry:

We, the members of "Team Louisiana", wish to express our appreciation for your foresight and the trust you placed in us at a time when the causes of failure were quickly being obscured in the rush to make repairs. Please accept the accompanying final report documenting our findings. As per the contract, we did not include recommendations in the body of the report. We include them here in the transmittal letter for your reference.

The impacts of the surge generated by Hurricane Katrina, a Saffir-Simpson Category 3 storm on landfall, are unprecedented in U.S. history. There is a potential for any forensics investigation to convey an apparent omniscience derived from 20:20 hindsight, and to lose sight of key points like this one. Team Louisiana tried to avoid this trap by focusing on what was known at the time the Greater New Orleans Hurricane Protection System (GNO HPS) was designed, the analytical tools that were available then, and what tools were used.

On the other hand, engineers – then or now – all work with uncertainty and follow accepted practice to account for unknowns that increase the risk of failure. As one of the senior Team Louisiana geotechnical engineers pointed out, it is the anomalous stratum, rather than the average soils condition, that generally causes foundation failure. Engineers address these uncertainties in levee and floodwall design by adding freeboard to raise crown elevation beyond the minimum specified, by inflating the stress to be resisted by a "factor of safety" sufficient to account for unknowns, and by incorporating redundant measures to limit the effect of the failure of a single component. These are some of the key features that distinguish a safe system from one that is unsafe. Such elements are the focus of this investigation.

The following key questions were formulated to guide the forensics investigation.

1. Was the GNO HPS properly conceived to accomplish the 1965 Congressional mandate to protect against the "most severe combination of meteorological conditions reasonably expected?"

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2. Were the levels of protection, or crown elevations, specified in designs for HPS elements sufficient to resist overtopping by surge and waves associated with the 100-year Standard Project Hurricane?
3. Did incorrect design assumptions compromise performance? Should these have been detected and corrected by engineers equipped with the tools available at the time?
4. Did the Mississippi River Gulf Outlet (MRGO), a free-flowing, deep-draft navigation canal that pierced the HPS on the eastern side, compromise system performance?
5. Was the system maintained and operated to assure the required level of protection through time? Specifically, how did the 40-year construction schedule impact system performance?

These questions are each answered in a separate chapter of the report, with a brief recapitulation in the executive summary. The following are recommendations that were developed by the team as an outgrowth of our participation in the forensics effort.

Independent Review of All Levee Systems and Protection Projects

- Katrina was a largely man-made catastrophe triggered by a moderately fast Category 3 hurricane that missed New Orleans. Citizens were denied the level of protection mandated by Congress in the 1965 Flood Control Act. Accordingly, we recommend that the US Congress empanel independent review teams, with substantial participation by Louisiana scientists and engineers, to assess the integrity and safety of all existing federal and state levee systems in Louisiana, including those currently under repair. Similarly, we recommend that the state – perhaps through its newly consolidated levee boards -- carefully assess the safety and reliability of all proposed federal projects that could affect public safety or the functioning of ecosystems, particularly as they will be affected by sea level rise and subsidence. The Louisiana Legislature should ensure ongoing funding for this purpose. Interactive consultation and review by consulting panels of leading outside experts is common practice in dam engineering.
- Based on the failures studied by Team Louisiana, no cantilevered sheet pile structures nor "I-walls" in southeastern Louisiana should be certified to sustain hurricane loadings without careful inspection and analysis of the geotechnical data used in the design, by the independent review team mentioned above. All I-walls should be re-evaluated for current design loadings assuming a water filled gap along the flood side of the wall. All levees underlain by soft clay or other such questionable soils should be re-evaluated for current design loadings accounting for reduced shear strength of soils in areas at or beyond the toe of the levee. Any walls found structurally sound should be provided with splash pads to prevent failure under overtopping conditions. It should not simply be assumed that pile-supported 'T-wall' systems are safe.
- Louisiana should take the lead in determining the level of hurricane protection that should be provided to citizens of the state. This is a policy decision that should not be left to federal agencies or outside experts. A risk-based approach is better than the obsolete "Project Storm" approach, but it would be even more useful to strive for a particular public safety or policy goal, like protection for New Orleans at a level that

renders evacuation undesirable. The Louisiana Legislature should empower and fund Louisiana Department of Transport and Development to undertake this critical task.

8-29 Commission/Levee Commission

- All of the existing forensics reports, including ours, raise technical questions about the way in which the USACE designs and builds projects with critical life-support functions, but do not tell us why decisions were made in the way they were, and therefore cannot build confidence in the USACE going forward.
- Transparency in dealing with the public is a must. Citizens of New Orleans were never told by those with both knowledge and responsibility just how vulnerable they were to flooding, or of the public safety compromises made in designing and building structures. It is extremely important that the capacity of the existing protection system be fully communicated to the public, as well as the public safety consequences of upgrades and repairs. They need to understand the risks for living behind the federal levee system.
- Because trust is more difficult to rebuild than levees following catastrophic failure, we recommend that the issues raised in the forensics portion of the Team Louisiana and Independent Levee Investigation Team (ILIT) reports form the basis for an official inquiry, by US Congress, into how mistakes with such tragic consequences were made.
- The unique blanket immunity that the USACE enjoys in the law from liability for defective design of flood control projects should be re-examined, by the US Congress, and carefully restricted to ensure lines of corporate and professional responsibility are clear and traceable.
- An official inquiry along the lines of the "truth and reconciliation" commissions that have followed political turmoil in other countries would seek not to brand scapegoats but to encourage those who with special knowledge to explain what they know without fear of retribution to ensure that the same mistakes are not made again. The goal is to allow both those harmed and those who were responsible to move beyond the tragedy with rebuilt respect and trust into a very different future.
- Following on the 8-29 Commission/Levee Commission, the US Congress should pass a "Katrina Recovery Bill" that will ensure that coastal restoration and protection are fully federally funded, and New Orleans' recovery supported over the long-term, in recognition of the role played by federal decisions in contributing to the losses.

Integration of Navigation, Coastal Protection and Restoration Projects

- Unlike a river flood that may last for months, the challenge presented by a hurricane surge lasts only a matter of hours at any one point. An initial Master Plan is being conceptualized by the State through the Coastal Protection and Restoration Authority (CPRA). We recommend that the State invest in a more rigorous effort to go beyond concepts laid out in the CPRA plan to integrate coastal restoration and protection projects in ways that will accomplish important policy goals, such as eliminating the need to evacuate New Orleans, for example. The current draft CPRA Master Plan does include recognition of the surge and wave reduction potential of natural landscape features like wetlands and barrier islands, but does not specifically incorporate many of the lessons of Katrina and Rita with regard to the reliability of engineered structures.

- All existing federal navigation projects in coastal areas should be evaluated by independent investigators using modern surge and wave modeling techniques to determine the degree to which they continue to compromise existing storm flood protection. This action should be fully funded by the US Congress, not undertaken by the USACE, and the state must have a significant role. This action can form the basis for Federal Emergency Management Agency (FEMA) remedial retrofit plans. The MRGO and other channels in the funnel must immediately be fitted with appropriate closure features by the USACE to ensure that they do not serve again as a conduit for surge and waves to Greater New Orleans.

Relationship between Local Sponsors and the Federal Government

- Local levee boards and other sponsors in the Greater New Orleans area kept levees and rights of way mowed, operated drainage structures, commented on USACE design memoranda, and participated in inspections. They were not, however, consulted on critical design or construction decisions. On the other hand, they had to pay 30 percent of all costs incurred for a level of protection that appeared on some reaches to diminish over time. The USACE was unresponsive to critiques coming in from cost-sharing partners and was often ready to pass incomplete project elements to local authorities without local concurrence. The sponsors were expected to rubber stamp USACE design documents. Only by withholding cost-sharing funds could these partners bring attention to technical concerns, and this tended to make every technical issue into a political one. The one-sided relationship between local sponsors and the USACE on technical management and oversight of cost-shared projects should be changed by the US Congress to create an atmosphere in which technical inquiries are encouraged and given respectful treatment outside of a political arena.
- We recommend that all levee certifications necessary for local government participation in the federal Flood Insurance Program be renewed on 5-year or 10-year intervals based on data that is stamped by professional engineers and available for public inspection, rather than a simple blanket assertion by the USACE.
- The State should establish clearer lines of responsibility when it comes to the operation and maintenance of the drainage systems and flood control systems. One problem is that the federal projects are never completed, rendering a clean hand-off to local authorities impossible. It is hoped that the consolidated levee boards established by statewide ballot in Louisiana in 2006 will improve coordination.

A Solution to the Settling of Levee Structures

- Settling of levees and floodwalls is a recognized factor affecting the reliability of these features. We recommend that the State and USACE adopt a life-cycle approach to comparing alternatives for critical flood control structures that gives more weight to on-time completion and reliability. Because of settlement and subsidence, it is essentially impossible to ever finish construction of gravity supported levees, or floodwalls that depend on levees for support (e.g. I-walls), in the GNO area. Actual crown elevations for these structures describe a trajectory over time between enlargements such that the actual level of protection rarely corresponds to the design level. In the interest of completing projects on a reasonable schedule, the State and USACE should consider using pile-supported protective structures to a much greater degree than in the past even if the first

construction cost is much higher. Construction lifts could conceivably be limited with deep pile supported floodwalls and barriers.

The infrastructure failures observed in the New Orleans Area and described in the accompanying Team Louisiana report resulted in tragic loss of life and devastating property damage that continues to threaten the viability of the State's largest city. The failures were foreseeable, for the most part, and could have been prevented at a fraction of what it has cost to repair the current system. Although it has been a somber task, we have appreciated the opportunity that you provided for us to dig deeply into the details of what went wrong. There are many hard-earned lessons, and we have provided the recommendations listed above in the hope that the mistakes we make in the future will at least be different, and that we have done all that we can to create a more reliable system for our children and grandchildren.

Sincerely,

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